Supporting Information

Facile ball-milling synthesis of CuO/biochar nanocomposites for efficient removal of reactive red 120

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Section 1. Preparation of CuO under different ball milling conditions

The procedure of optimization ball-milling parameters was as follows: 1.8 g CuO power and 90 g agate balls (balls-to-CuO mass ratio = 50:1) were placed in 500mL agate jars, and then operated at a rotational speed of 400 rpm for 9 h in ambient air. To obtain the milling time effect, 1.8 g CuO was mixed with 90 g balls at a speed of 400 rpm for 3, 6, 9, 12, and 18 h, respectively. In order to study the effect of the milling rotational speed, 1.8 g CuO power and 90 g balls were mixed into 500 mL agate jars and grinded 3 h with the varying speed from 100 to 500 rpm (i.e., 100, 200,300, 400, 500 rpm). To investigate CuO-to-balls weight ratio effect, the various quantities of agate balls (36 g, 90 g, 126 g, 180 g) and 1.8 g CuO (i.e., balls-to-CuO = 20:1, 50:1, 70:1, 100:1) were added into 500 mL agate jars for 3 h by the string speed of 300 rpm.

Section 2. Adsorption kinetic models

The adsorption experiment data on the adsorption of RR 120 by the adsorbent were further fitted to three widely used reaction kinetic models such as pseudo-first-order, pseudo-second-order model and Elovich model to research the adsorption process [1]. The nonlinearized equations were given respectively by Eqs. (1) – (3):

Pseudo-First-Order model: $q_t = q_e\left(1 - e^{-k_1 t}\right)$ (1)

Pseudo-Second-Order model: $q_t = \frac{k_2 q_e^2 t}{1 + k_2 q_e t}$ (2)

Elovich model: $q_t = \frac{1}{\beta}\ln\left(\beta\alpha t + 1\right)$ (3)

Where q_t and q_e are adsorption capacity (mg g^{-1}) of RR 120 at any time t (h) and at equilibrium time, respectively. k_1 (h^{-1}) and k_2 (g mg^{-1} h^{-1}) represent the sorption rate constant for pseudo-

first-order model and pseudo-second-order model, respectively. α (mg g^{-1} h^{-1}) is the initial adsorption rate constant, and β (g mg^{-1}) is the desorption constant. Pseudo-first-order and pseudo-second-order models are semi-mechanistic models based on the assumption of physisorption and chemisorption process, respectively. However, the Elovich model is an empirical equation describing multi-mechanism adsorption processes [2].

Section 3. Adsorption isotherm models

To effectively examine the adsorption behavior, the adsorption equilibrium isotherms of RR 120 were simulated with two well-established adsorption isothermal models, namely, the Langmuir and Freundlich models [3]. The equations of the theories are written as:

Langmuir model: $$q_e = \frac{q_m K_L C_e}{1 + K_L C_e} \quad (4)$$

Freundlich model: $$q_e = K_f C_e^{n_f} \quad (5)$$

Where C_e (mg L^{-1}) is the equilibrium concentration of the RR 120 solution, q_m (mg g^{-1}) denotes the theoretical maximum adsorption capacity of RR 120, K_L (L mg^{-1}) and K_f ($mg^{(1-n)}$ L^n g^{-1}) are the Langmuir and Freundlich isotherm constant, respectively. n_f (dimensionless) is exponential coefficient related to surface heterogeneity.

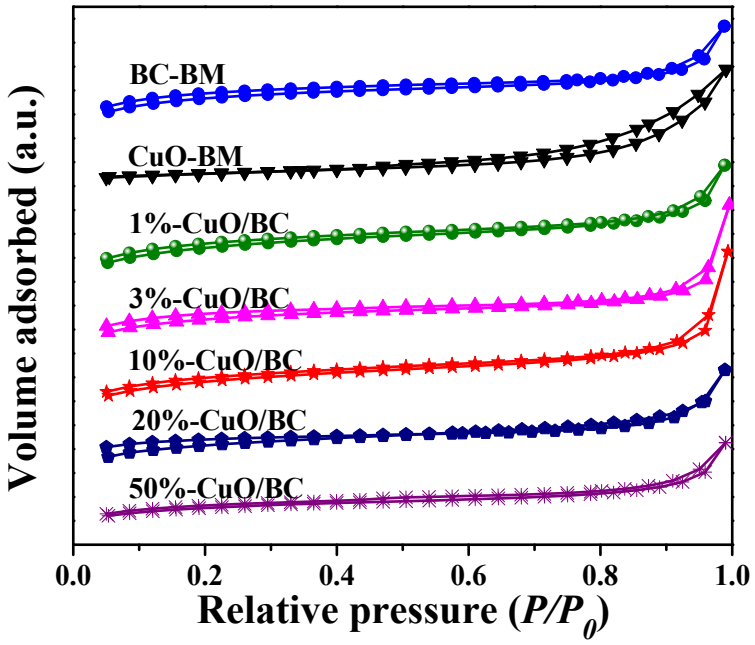

Figure S1. N_2 adsorption and desorption isotherms for CuO-BM, BC-BM, CuO/BC composites.

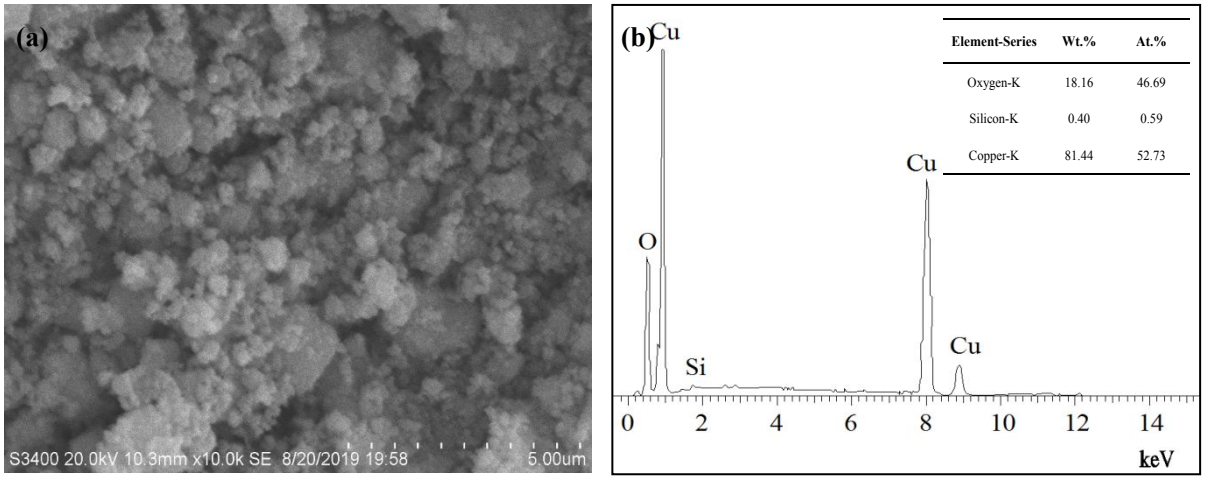

Figure S2. (a) SEM image and (b) EDX spectra of CuO-BM sample.

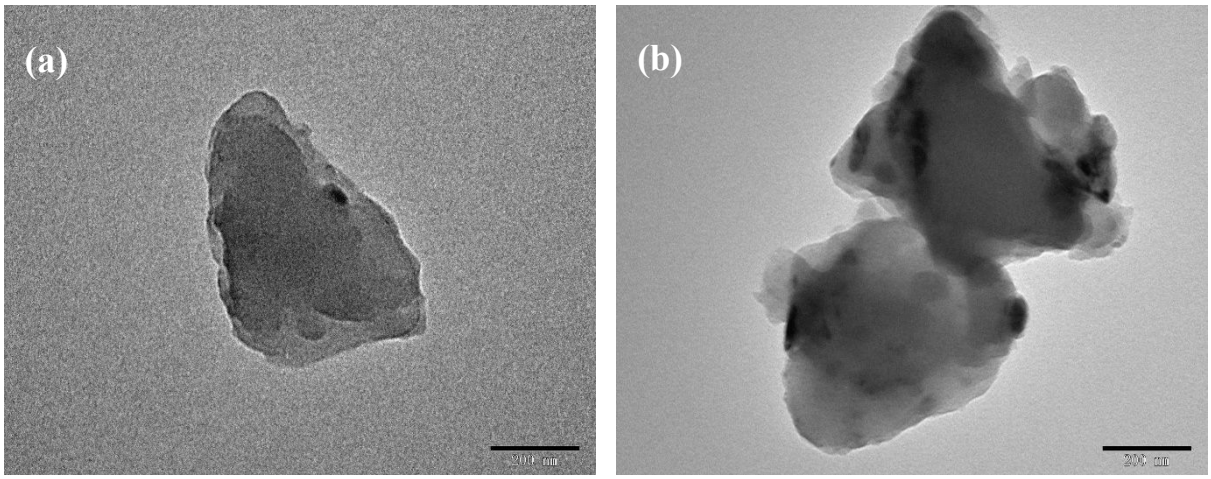

Figure S3. TEM images of (a) BC-BM and (b) 10%-CuO/BC samples.

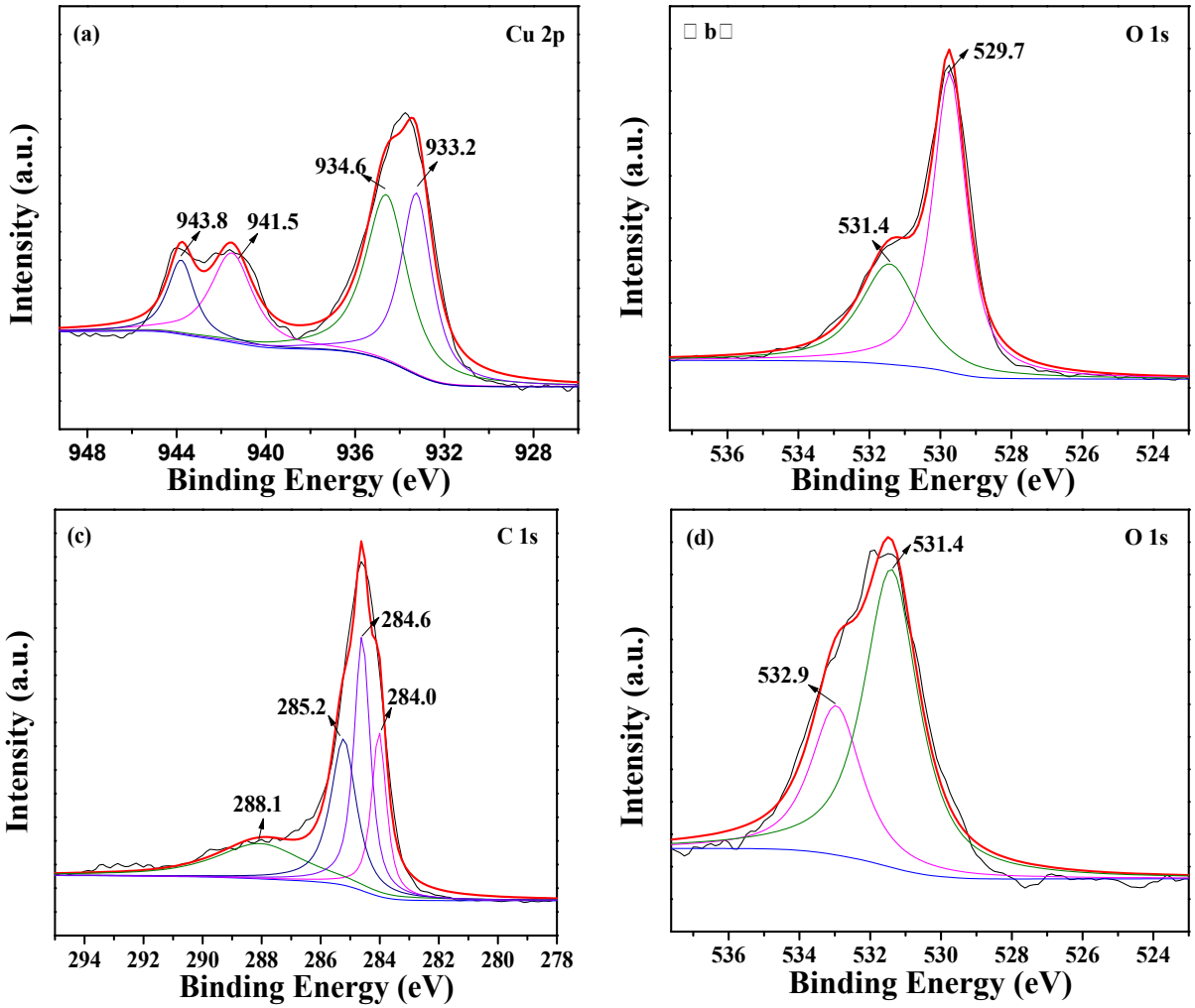

Figure S4. XPS spectra of CuO-BM: (a) Cu 2p, (b) O 1s; BC-BM: (c) C 1s, (d) O 1s.

References

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